

# IBM Challenge

## Lab 2

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# Set-Up

Use Python 3.10 or 3.11

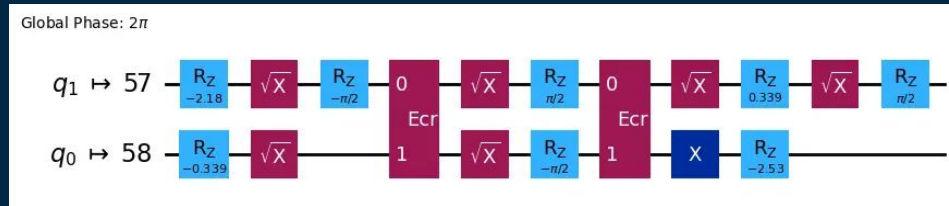
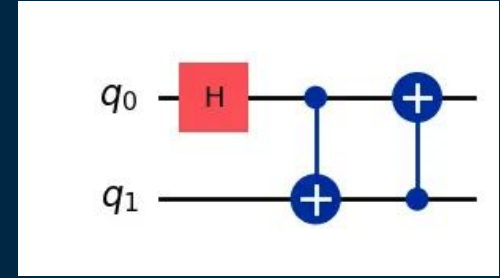
Do not use Python 3.12 or above

Since Lab 3 and beyond need ray.

- ### Install Qiskit and relevant packages, if needed
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- `pip install qiskit[visualization]==1.0.2`
- `pip install qiskit_ibm_runtime`
- `pip install qiskit_aer`
- `pip install qiskit-transpiler-service`
- `pip install graphviz`
- `pip install`  
`git+https://github.com/qiskit-community/Quantum-Challenge-Grader.git`

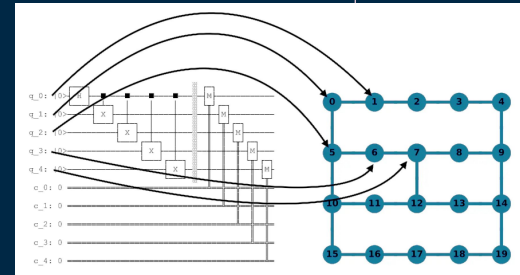
# Transpiler

- Process of taking a given input circuit
- Rewriting it to an equivalent circuit for a specific quantum device/system
- Goal: best performance to reduce noisy quantum hardware



# Six Stages of Compilation Flows

- Init: This stage is used to translate any gates that operate on more than two qubits, into gates that only operate on one or two qubits.
- Layout: This stage applies a layout, mapping the virtual qubits in the circuit to the physical qubits on a backend.
- Routing: This stage runs after a layout has been applied and will inject gates (i.e. swaps) into the original circuit to make it compatible with the backend connectivity.
- Translation: This stage translates the gates in the circuit to the target backend's basis set.
- Optimization: This stage runs the main optimization loop repeatedly until a condition (such as fixed depth) is reached.
- Scheduling: This stage is for any hardware-aware scheduling passes.

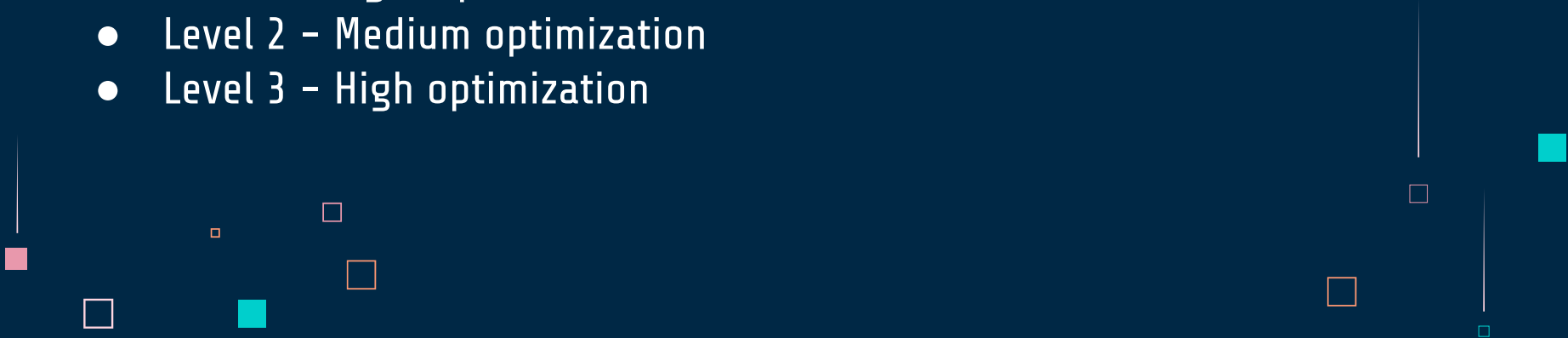


# Optimization Levels

Higher optimization levels generate more optimized circuits at the expense of longer compile times, and vice versa.

There are 4 Optimization Levels

- Level 0 – No optimization (typically used for hardware)
- Level 1 – Light optimization
- Level 2 – Medium optimization
- Level 3 – High optimization



# Transpile with Preset Pass Managers

- Pipeline determined by **PassManager** and **StagedPassManager** .
  - PassManager is a collection of “passes”
  - StagedPassManager executes and determines order of PassManager objects.
- Qiskit provides 4 optimization levels of transpilation.
- Users can modify these presets.
- Users can also construct a pass manager to build your own custom pipeline that can transform input circuits.

# Build your own Pass Managers

One of the powerful features of the Qiskit v1.0 transpiler is its flexibility. It allows you to compose a PassManager with only two or three stages. It also allows you to put your own Pass at desired stages.

- Create a pass manager for dynamical decoupling.
- Adding a pulse sequence to flip idle qubits around the Bloch sphere.
- Mitigates the effect of noise channels, suppressing decoherence.

This is what you are tasked with in Exercise 5 of Lab 2.

```
X = XGate()  
Y = YGate()  
  
dd_sequence = [X, Y, X, Y]
```

# References

- [GitHub Lab2](#)
- [ChatGPT](#)
- [Transpiler Plugins Doc](#)
- [Pass Manager Doc](#)
- [Quantum Circuit Doc](#)

